

Engel
Bulletin 145.

February, 1898.

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

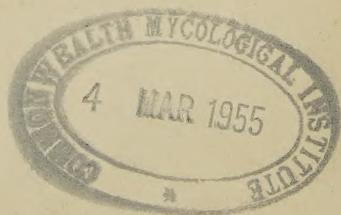
BOTANICAL DIVISION.

Some Important Pear Diseases.



By B. M. DUGGAR.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1898.



ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	-	-	-	-	-	Trustee of the University.
Hon. B. F. TRACY,	-	-	-	-	-	President State Agricultural Society.
Professor I. P. ROBERTS,	-	-	-	-	-	Agriculture.
Professor G. C. CALDWELL,	-	-	-	-	-	Chemistry.
Professor JAMES LAW,	-	-	-	-	-	Veterinary Science.
Professor J. H. COMSTOCK,	-	-	-	-	-	Entomology.
Professor L. H. BAILEY,	-	-	-	-	-	Horticulture.
Professor H. H. WING,	-	-	-	-	-	Dairy Husbandry.
Professor G. F. ATKINSON,	-	-	-	-	-	Botany.
M. V. SLINGERLAND,	-	-	-	-	-	Entomology.
G. W. CAVANAUGH,	-	-	-	-	-	Chemistry.
L. A. CLINTON,	-	-	-	-	-	Agriculture.
B. M. DUGGAR,	-	-	-	-	-	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	-	-	-	-	-	Director.
E. L. WILLIAMS,	-	-	-	-	-	Treasurer.
EDWARD A. BUTLER,	-	-	-	-	-	Clerk.

In pursuance of the provisions of Chapter 128 of the Laws of 1897, several persons were appointed investigators and instructors to serve throughout the state for a portion or all of the year as the demands of the work required.

See Bulletin 146, Report of Progress.

Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

Bulletins Issued Since the Close of the Fiscal Year, June 30, 1897.

- 139. Third Report upon Japanese Plums.
- 140. Second Report on Potato Culture.
- 141. Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
- 142. The Codling-Moth.
- 143. Sugar Beet Investigations.
- 144. Suggestions on Spraying and on the San José Scale.
- 145. Some Important Pear Diseases.

CORNELL UNIVERSITY, ITHACA, N. Y.,
March 1, 1898. }

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY:

Sir.:—This bulletin is our first attempt to answer the many questions respecting the diseases of the pear. There is a special reason for taking up the investigation from the fact that the common leaf disease of the pear in this state is a different fungus than has been supposed. The inquiry has shown that two very distinct diseases have been confused, and in the future we should speak of leaf-blight less and of leaf-spot more. The bulletin also calls attention to the dreaded fire blight; and although nothing can be done to directly intercept the disease, the injury may be somewhat averted if the grower's eyes are so sharpened that he discovers the disease upon its first appearance.

I. P. ROBERTS,
Director.

SOME IMPORTANT PEAR DISEASES.

I. LEAF-SPOT.

1. GENERAL ACCOUNT.
2. GEOGRAPHICAL DISTRIBUTION OF THE FUNGUS.
3. OCCURRENCE IN ORCHARDS.
4. SPRAYING EXPERIMENTS IN THE ORCHARD.
5. OCCURRENCE IN THE NURSERY.
6. MICROSCOPIC CHARACTERS.

II. LEAF-BLIGHT.

1. GENERAL ACCOUNT.
2. MICROSCOPIC CHARACTERS.
3. OCCURRENCE IN ORCHARDS, AND REMEDIES.
4. OCCURRENCE IN NURSERIES, AND REMEDIES.
5. REFERENCES TO LITERATURE.

III. PEAR-SCAB.

1. GENERAL ACCOUNT.
2. SPECIAL CHARACTERS OF THE FUNGUS.
 - (a.) *Microscopic Appearance.*
 - (b.) *How the fungus passes the winter.*
 - (c.) *Does pear scab differ from apple scab?*
3. VARIETIES AFFECTED.
4. REMEDIES.
5. REFERENCES TO LITERATURE.

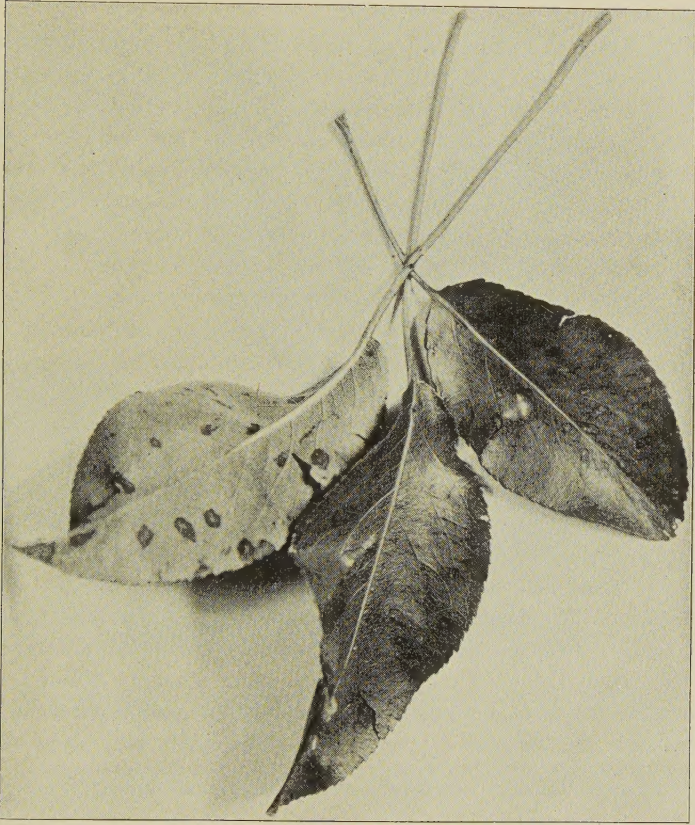
IV. PEAR BLIGHT.

1. GENERAL APPEARANCE.
2. HISTORICAL.
3. SPECIAL FEATURES OF THE DISEASE.
 - (a.) *The Bacteria.*
 - (b.) *Kinds of trees affected.*
 - (c.) *Bacteria in the flowers.*
 - (d.) *Bacteria in the wood.*
4. REMEDIES.
 - (a.) *The knife and the saw.*
 - (b.) *When to cut.*
 - (c.) *Conditions favoring the disease.*
5. REFERENCES TO LITERATURE.

I. LEAF SPOT.*

I. GENERAL ACCOUNT.

In horticultural writings much attention has been given to the



157.—*Leaves of Anjou pear injured by leaf-spot fungus.*

leaf-blight of the pear, a disease sometimes called leaf-spot. The leaf-blight is a fungus of wide distribution and of much economic

* *Septoria piricola* Desm.

importance. Recent critical study, however, shows that an entirely different injurious pear-leaf fungus is very probably much confused with the leaf-blight. I would suggest that the name leaf-blight may well be confined to the well known disease about which so much has been written, and that the term leaf-spot may appropriately be used to denote the fungus to which I wish here to call special attention.

This leaf-spot is not one of those fungi of minor economic importance to be wholly neglected, or which should secure attention at the hands of botanists alone. Nevertheless, in this country it had not been mentioned in the bulletins or other economic publications until the notes sent out from this laboratory last year;* yet it has been casually mentioned in several German works.† I do not find anywhere, however, that it has received deserved attention from the economic point of view, being entirely overlooked or neglected in this country.

While studying some pear diseases during the summer of '95, Professor Atkinson found this leaf-spot abundant in the orchards of Ithaca and vicinity, and before the close of the summer he observed it at Syracuse and Geneva, where considerable injury was done to the foliage of orchard trees.

During the season of '96 and '97 I have continued observations upon this leaf-spot, and it proves to be a disease of considerable importance, and a fungus widely distributed. To the ordinary observer the character of the spots may not seem to differ materially from those of the leaf-blight, but careful observation will readily distinguish them. The mature leaf-spot as it appears on the green leaves is usually larger, more sharply defined, and somewhat angular, being roughly limited by subdivisions in the venation. See figures 157 and 158.‡ The spots may show three

*¹) Atkinson, Geo. F. — Leaf-spot of Pear. *Garden and Forest*, X. pp. 73-74, 1897.

²) Duggar, B. M. — Another Injurious Leaf-spot of Pear. *Report Proceedings West. N. Y. Hort. Soc.* 1897.

†¹) Sorauer, P. — *Pflanzenkrankheiten*, Zweite Auflage, II. p. 390.

²) Tubeuf, K. F. Von. — *Diseases of Plants Induced by Cryptogamic Parasites* (English edition), p.

‡ Figures 157, 166, 168, and the frontispiece are from photographs made by Professor Geo. F. Atkinson.

fairly well differentiated zones of color. The center is grayish white, and herein appear the minute black fruit-bodies, or pycnidia, in which the spores are borne. The next zone is brown, and this often grades into a region purplish in color. The details of these characters are lost in old or dried leaves; but the cluster of fruit-bodies is very evident in the center of the spot on



158.—*Small, angular spots produced by the leaf-spot fungus on an unknown variety of pear in a neglected orchard.*

one or both surfaces of the leaf, especially if examined with a hand lens.

2. GEOGRAPHICAL DISTRIBUTION OF THE FUNGUS.

There is every reason to believe that in New York State this fungus is to be found wherever there are pears. I have collected it in three-fourths of the counties bordering the N. Y. C. and H. R. R. R. from Buffalo to New York, and it is also abundant

in south central portions of the state. It has been sent to me from Pennsylvania, Maryland and Virginia, and pear leaves from Alabama show spots characteristic of this disease, although the immature condition of the fungus render a definite determination difficult. Nevertheless, from the above we are assured of its general distribution in the eastern states, and in many places it is the most abundant leaf fungus of the pear.

3. OCCURRENCE IN ORCHARDS.

By far the majority of observations as to distribution were made upon orchard trees, since these are generally more accessible. Fortunately, there is no evidence to show that this disease ever attacks the fruit, so that there is little danger of losing a growing crop. The foliage of susceptible varieties, however, is often greatly injured by mid-summer, and many trees are partially defoliated in August. At Black Hook I observed a number of yard pear trees more than half defoliated on June 17. At Cayuga large blocks of several varieties were considerably defoliated by the latter part of August, but during the midsummer the leaves were only spotted and somewhat discolored. Under ordinary circumstances, a number of varieties are so slightly injured that the defoliation is scarcely evident before the appearance of frost, unless there are adjacent resistant varieties for comparison. At any rate, many varieties suffer more or less, and even though affected leaves should adhere until after the summer pears are gathered, the injury to the leaf throughout the summer and its fall a month or more before the normal time are sufficient injuries to demand our attention. We must assume that the vigor of the tree is thus reduced for the perfection of its product another year. Only a series of experiments through a period of years could determine accurately the extent of such injuries.

There has been collected a considerable amount of data as to varieties affected, but mostly in small orchards. Such matters are also liable to great variation, and I present a general account merely for the suggestion it may give. In this connection notes on a single orchard are valuable for the comparison of varieties, as far as they go. In the orchard of Mr. H. S. Coleman, of

Geneva, no spraying was done during '96. In round numbers there were about one thousand trees, distributed as to number in variety as mentioned below. In order of injury, this one orchard gave the following results,—defoliation being not very great, even on Oct. 1, it is mainly a comparison of leaf injuries:—

Variety.	Number of trees.	Effect.
Bosc.....	1-5	Quite bad.
Anjou.....	100	"
Louise Bonne.....	10-25	"
Giffard.....	1-5	"
Buffum.....	1-5	"
Clairgeau.....	10-25	Considerable.
Summer Doyenne.....	1-5	"
Seckel.....	100	"
Sheldon.....	10-25	"
Bartlett.....	100	"
Lawrence.....	10-25	"
Flemish Beauty.....	10-25	Slight.
Josephine de Malines.....	1-5	"
Vicar of Winkfield.....	1-5	"
Clapp's Favorite.....	10-25	"
Reeder.....	1-5	Very slight.
Souvenir du Congress.....	1-5	"
Duchess.....	500	"
Winter Nellis.....	1-5	None.
Kieffer.....	1-5	None.

On the University grounds the orchard of the department of horticulture was given at least one spraying during the season of '96, but even here the disease was generally prevalent to slight extent. Observations upon this orchard and upon others indicate that among the varieties more commonly cultivated, Anjou, Seckel, Bosc, Summer Doyenne, and Bartlett are very generally affected to considerable extent; Louise Bonne, Clairgeau, Clapp's Favorite, Flemish Beauty, and others much less, falling into an intermediate and variable grade; Duchess uniformly very slightly affected; and Kieffer free from the leaf-spot fungus.

The leaf-blight fungus in pear orchards is apparently not very abundant in this state, and instances of the confusion of the leaf-spot with the leaf-blight have come to our attention. This may account for the statement that the leaf-blight, although of general occurrence in New York, rarely causes cracking of the fruit in this state. Leaf-spot never affects the fruit. Nevertheless,

one can not go amiss in the treatment of these diseases, mistaking one for the other, for the treatments as suggested are about the same.

4. SPRAYING EXPERIMENTS IN THE ORCHARD.

For the season of '97 it was decided to make some experiments for the prevention of this leaf-spot. Cayuga seemed our most convenient point, and on visiting some orchards at that place, I found that a small orchard owned by H. S. Wiley contained a number of trees of two desirable varieties, and upon an examination of the old leaves of the previous year, it was found that the leaf-spot had been present to considerable extent. Mr. Wiley consented to having the work done, and put his orchard at our disposal, as well as the use of his barrel pump; and I was assisted in the work by F. T. Wiley.

As originally planned, these experiments were designed to test the effect of three standard fungicides, the number of sprayings necessary, and the best time for spraying. Owing, however, to a difficulty in securing certain materials for the first application, the original plan could not be fully carried out.

The three fungicides used and the formulæ employed were as follows:

Bordeaux.

Sulphate of copper (blue vitriol).....	6 pounds.
Quick lime.....	4 pounds.
Water.....	50 gallons.

Ammoniacal copper carbonate.

Carbonate of copper.....	5 ounces.
Strong ammonia.....	3 pints.
Water.....	45 gallons.

Liver of sulphur solution.

Potassium sulphide.....	30 ounces.
Water.....	50 gallons.

The general arrangement of the orchard is given in the diagram below. The only changes from original settings are that in row A, Nos. 3, 4, and 5 are top grafted to Idaho; in B, No. 1 to Vermont Beauty, and throughout No. 8 the trees are top grafted to Kieffer. Missing trees are indicated by crosses.

The original rows run as indicated by the lettered rows, and the spraying was made across both varieties, hence according to the numbered rows.

to the autumn frosts, will show better the final status of the protection rendered.

Row 1, very slightly affected. Leaves green and fresh.

Row 2, same as 1.

Row 3, almost no indication of spot. Leaves remarkably healthy.

Row 4, about the same as 3.

Rows 4 and 5, affected by the spot to considerable extent, but almost no defoliation by Sept. 1. Badly spotted and slightly defoliated on Oct. 5.

Rows 7 and 9 badly defoliated.

Row 10, slight attack throughout, Seckels showing more injury.

Row 11, badly spotted, about as in 5 and 6.

Row 12, injured throughout, but not so much as row 11.

At this time, and even earlier, the difference between the check rows and certain of the sprayed rows was so evident as to be noticed at considerable distance. The sprayed trees maintained their leaves well, and the earliest autumn winds were not sufficient to jar them off. This became so evident late in October, that Mr. Wiley further emphasized my earlier observations by writing me. "The trees you sprayed (that is the fruiting pear trees) have retained their leaves most remarkably, while the others are now all defoliated."

Figure 159 shows, in the center, rows 3 and 4 sprayed with Bordeaux; and on the right, rows 1 and 2, sprayed with ammoniacal copper carbonate.

Figure 160, at the center, gives comparison between the check, on the right, and three sprayings with ammoniacal copper carbonate on the left.

Summarizing the spraying experiments, it is well to suggest that three sprayings with Bordeaux gave almost perfect protection against the leaf-spot. This spot may probably be quite effectually treated by the usual treatments given for pear scab. Where the codling-moth, but not the scab prevails, the first treatment may be made in conjunction with the Paris green application, immediately after the petals fall, and two subsequent sprayings at intervals of two or more weeks, if thoroughly done, would secure protection throughout the season, it appears. My obser-



159—Central low rocks sprayed with *Leodanum*. Kams in the right sprayed with ammoniacal copper sulfate.



15.—In the center, to the right, is row 9, unsprayed; and to the left, row 10, sprayed three times with ammoniacal copper carbonate.

vations have been, moreover, that neglected orchards, trees in turf and in small garden lots are more affected than a properly cultivated orchard.

5. OCCURRENCE IN THE NURSERY.

The principal nursery regions which I have examined in this connection are those in the vicinity of Dansville, Geneva, and Cayuga. While the leaf-blight is the financial bane of seedling pears, this leaf-spot is uniformly the fungus monopolist of budded stock after the first year. Budded stock of two years or older is often badly injured late in the summer, and occasionally I have found the leaf-spot to a considerable extent upon one year stock. Although well aware of its presence, nurserymen as a rule do not consider this sufficiently injurious to warrant their attention, especially as there is greater difficulty in spraying the stock of the second year; but many realize that it would be desirable to spray. Some make a practice of spraying the one-year stock early in the season, but those who do this are few, and the fact remains that it suffers less injury than older stock. As to the cause of this apparent immunity, several prominent nurserymen agree that with an abundance of room and with the



161—*Sprayed late with Bordeaux.*

good culture usually given the first year, the plant finds such favorable conditions as readily to hold the mastery. This is



authenticated by my observations on older stock, which seem to be less affected when the culture has been well attended to. Nevertheless, the spot is abundant on certain varieties in spite of any culture which I have seen.

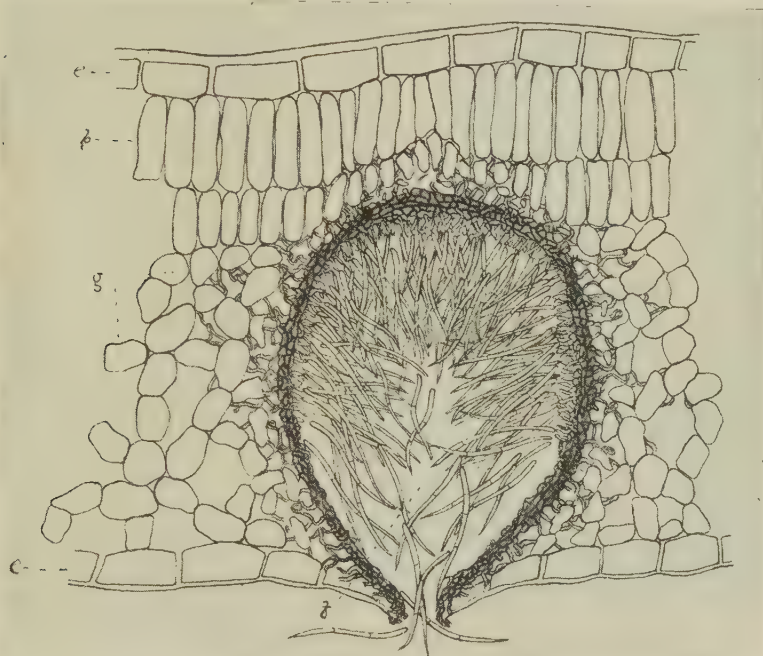
Extensive notes have been taken as to the extent of injury among the different varieties, but there is so much variation that no definite statement should be made at present. Certainly, however, thus far Anjou, Seckel, Sheldon, Summer Doyenne, Dana's Hovey, Frederick Clapp, and Bartlett have shown the greatest injury, somewhat in the order named; Duchess

162—*Sprayed with ammoniacal copper carbonate.* very slightly affected, with Kieffer quite free; and all of the remaining varieties ordinarily grown suffer more or less.

Spraying experiments on rather old nursery stock were also begun at Cayuga, but through an unfortunate misunderstanding most of the stock was removed after the second spraying, and the only result of interest is the comparison between a few Seckels and Anjous, sprayed late with Bordeaux and ammoniacal copper carbonate respectively. Figures 161 and 162 indicate these comparisons.

6. MICROSCOPIC CHARACTERS.

A thin section through a diseased spot* is shown in figure 163. Here we see at *e* the outer cell layer, or epidermis, of the



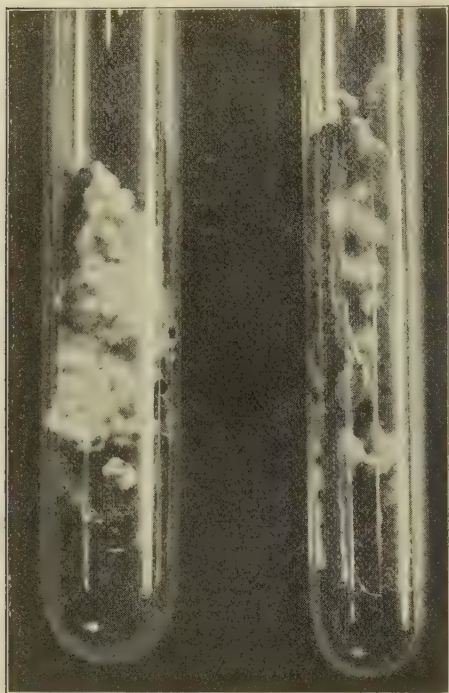
163.—Cross section through a leaf-spot, showing the fruit body and spores of the leaf-spot fungus.

leaf on both sides. At *p* is shown the palisade layer of cells often containing so much of the green coloring matter of the leaves,

*Portions of leaves showing the fungus, after being properly fixed and dehydrated, were imbedded in paraffine, sectioned, and stained. The Ehrlich-Biondi-Heidenhain combination works well, staining green the deadened host cells and older hyphal elements, while the basidia, younger hyphæ, and fresher leaf tissues are colored red. A carmine and nigrosin combination also works well.

The spores do not germinate very readily in agar alone, but I have secured abundant germination in agar containing pear-leaf decoction. Isolated spores were then removed to bean-stem and pear-stem cultures.

and below this the general leaf tissue, *g.* *f* is a section through



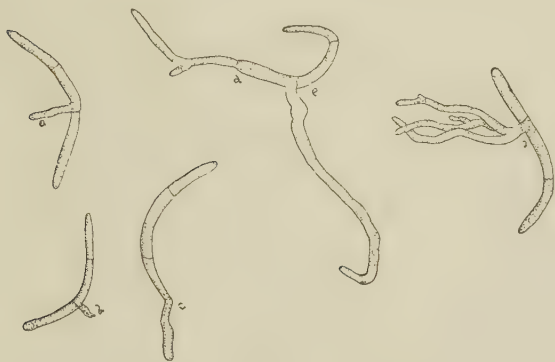
164.—Cultures of the leaf-spot fungus on pods and stems of bean.

figure 165. The germ tubes arise from either end (*c* and *d*), or

Here the fungus grew slowly at first, producing after several weeks the pycnidia of the *Septoria*. After several transfers this fungus grows quite luxuriantly on bean pods or stems, as seen in figure 164, producing the pycnidia in a short time, and the pycnidia are then not so definite in form but formed of a very loose stromatic mass. The submerged hyphæ are dark in color, while the aerial growth is dense and white, except the stromatic mass inclosing the pycnidium. I have had cultures for eighteen months; and although they have been subjected to various climatic conditions, nothing of further interest has as yet come from them. In nature the fungus is being closely watched for other stages, but I can say nothing definite upon this point at present, although other fungi have been found on the old leaves.

This *Septoria* is very evidently to be referred either to *S. piricola* Desm.

the hollow mature fruit body, or pycnidium, containing the countless spores. Each spore was originally borne on a little pedicel, or basidium, which seems to grow out from the wall. When the pycnidium is ripe, water is absorbed, and these masses of spores ooze out of the mouth of the pycnidium in a long horn-like projection, very dark in color. Here, then, they are at the surface ready for dissemination. With suitable conditions of moisture they germinate readily upon other pear leaves. Some germinating spores highly magnified are shown in



165.—Germinating spores of the leaf-spot fungus.

from the middle (*a*, *b*, *e* and *f*) of the spore, and readily penetrate the tissues of the leaf for the final production of another leaf spot.

II. LEAF BLIGHT.†

I. GENERAL ACCOUNT.

The above disease has been known in this country for many

or to *S. nigerrima* Fuck. Through the kindness of Professor W. G. Farlow, the American specimens have been compared with *S. piricola* in Desmaziere, *Herbier de la France*, and with *S. nigerrima* in the *Mycotheca Universalis* and in the Klotzsch collection No. 1755, to which Fuckel referred his *nigerrima* in the original description. Dr. Farlow would not regard the European specimens as distinct species; and our American form he finds, differs, if at all, only in that the spores are somewhat more nearly alike at both ends, whereas the European specimens may be somewhat blunter at one end. I have also compared the American specimens with No. 2259 of the Rabenhorst *Fungi europaei*, labeled *S. piricola*, and the two are identical. It will be noted that Saccardo doubts the distinctness of these two species from his query concerning the difference of color in the cirrae. In *S. piricola* they are described as white to olivaceous, while in *S. nigerrima* they are given as black. This, however, may be of slight importance since the description is evidently incomplete. The American specimen and the Rabenhorst are both 2-septate, thus agreeing further with the published description of *S. piricola* Desm.

† *Eutomosporium maculatum* Lev.

decades, and throughout this period it has figured in horticultural discussions. During the past ten years it has been freely discussed from the practical and scientific point of view in various publications of the U. S. Department of Agriculture, and in many bulletins of the various Experiment Stations. It will not be amiss further to emphasize the results of general interest, especially in connection with the notes already given concerning the leaf-spot. The leaf-blight is well known wherever the culture of the pear has been introduced, and since what is probably the same fungus occurs abundantly on the quince and some other members of the rose family, it finds abundant host plants for fruitful propagation in almost any region.

The spots are very evident on the upper surface of affected leaves. They occur at first as small discolored areas, becoming dull red with darker margins. Singly they are small with circular outlines; but often they are clustered together, or merged one into another. With age the spots are darker, losing some of their characteristics. The leaf often becomes yellowed or browned, and is readily detached from the branch by jarring. There may be seen in the center of the spots at maturity a minute dark papilla. As noted later, it is herein that the spores are borne.

The spots of this fungus are usually smaller than those of the leaf spot, more nearly circular, and not so clearly defined on the under surface.

On the fruit the spots of the leaf blight are red at first, but soon becoming darker. The drying of the epidermal layers of cells may cause a cracking of considerable extent, as in the case of pear scab, an injury from which rotting may readily ensue. The term cracking is no more to be applied to this disease, however, than to the scab. Figure 166 shows a pear merely spotted by the disease.

2. MICROSCOPIC CHARACTERS.

Making a thin section through the spot of this leaf blight where the blackened papilla is noted, authors have described the spores as massed just beneath the cuticle. These minute spores

are very unique in form, which to the imaginative mind of an early botanist suggested a miniature insect well provided with feelers; hence the generic name of the fungus, *Entomosporium*, expresses this resemblance. See figure 167 for individual spores.

The mycelium, or vegetative threads, of the fungus penetrate the epidermal layer, and to some extent the general tissue of the leaf, breaking down the cells considerably in that region of the leaf showing the spot.

With proper conditions these spores germinate readily, and ultimately produce again the spot wherever they secure an entrance into the tissues of the leaf. Sorauer claims that from the germination of the spore to the appearance of mature spores in the spot it may induce, about one month is required.*



167.—Pear injured by the leaf-blight fungus, showing no indication of cracking.

3. OCCURRENCE IN THE ORCHARD AND REMEDIES.†

The leaf blight has proved a pest to orchardists throughout the country, yet it has been less injurious in New York than in many states farther south and west. I find it more abundant in the Hudson Valley than in other sections of New York. It seems to

* NOTE. Sorauer has described at length a winter form or perfect stage of the *Entomosporium* which he has called *Stigmatea mespili*. On wintered leaves of quince Professor Atkinson has also found this fungus, and he has suggested referring it to the discomycetous genus *Fabrea*. See Garden and Forest, l. c.

† It is to be noted that in this connection we can refer to the results only as published, but owing to the comparative abundance of the leaf-spot in a few eastern states where the leaf-blight only has been reported upon, there is danger that some important mistakes have been made.

attack quite generally the varieties more commonly cultivated, although Duchess and Kieffer have often been reported resistant. Many varieties in one place reported free from the disease are reported badly injured in other sections.

Experimental work at various places throughout the country has shown that the Bordeaux mixture is the most efficient fungicide. Results obtained by the Division of Vegetable Pathology,



167.—*Spores of the leaf-blight fungus.*

both in nurseries and orchards, are especially encouraging. Work on a large orchard in Virginia, during 1893, made it clear that for the particular region early sprayings alone did not at all suffice, and that no very early applications are necessary for the treatment of this disease in the orchard. Unsprayed trees were badly defoliated early

in August, while trees which received two rather late sprayings—one after the leaves were well formed, and another within the course of a month—these were well protected. If thoroughly done, two sprayings seem to suffice. From the above piece of work, moreover, we learn that in treating 16,000 trees, the cost for two sprayings was less than two cents per tree. As mentioned in connection with the other pear diseases, the 50-gallon formula of Bordeaux is to be recommended.

4. OCCURRENCE IN NURSERIES AND REMEDIES.

In the nursery the principal damage is done to seedling pears, and further injury is usually to be attributed to the leaf-spot. As previously mentioned, the budded stock is much less frequently affected by the leaf blight. Seedling pears throughout the state, and generally throughout the country, suffer seriously from it. The youngest foliage is first affected, and often the leaves fall early in the season. Later in the season, the sunken reddish areas on the tips of the branches indicate the disease on those parts, and Sorauer has shown that in the latter places the disease may readily pass the winter. In this country Fairchild has also corroborated these views.

The premature hardening or ripening of the young wood pre-

vents the budding operation; or, if budding is not entirely prevented, the early cessation of growth in the formative cambium of the stock renders a perfect union of the woods difficult to secure.

The results of all properly conducted experiments upon nursery stock indicate that Bordeaux mixture as a fungicide is essential to success where this disease prevails. Five or more sprayings have not given perfect protection; but they have been extremely profitable on the American, French, and Japan stocks generally. In large nurseries, and with horse-power machines, the cost should not exceed twenty-five cents for each one thousand trees.

REFERENCES TO LITERATURE.

- CHESTER, F. D.—The Treatment of the Leaf Blight of the Pear and Quince. Bulletin XIII., Delaware Experiment Station, 1891.
 Present Status of Knowledge on the Treatment of Pear Leaf Blight. Report Delaware Experiment Station, 1891, pp. 44-46.
- (FAIRCHILD, D. G.)—Pear Leaf Blight. Abstract in Report Department Agriculture, 1892, p. 226.
- FAIRCHILD, D. G.—Experiments in Preventing Leaf Diseases of Nursery Stock in Western New York. Report New York Experiment Station, 1892, pp. 642-652.
 Experiments with Fungicides to Prevent Leaf-Blight of Nursery Stock. Journal Mycology VIII., No. 4, pp. 338-351.
- * GALLOWAY, B. T.—Experiments in the Treatment of Pear Leaf Blight, Cracking and Scab. Bulletin 3, Div. Vegetable Pathology pp. 36-47, 1892.
 The Effect of Spraying with Fungicides on the Growth of Nursery Stock. Bulletin 7, Div. Vegetable Pathology, 1894.
- KINNEY, L. F.—The Leaf Blight of the Pear. Bulletin 27, Rhode Island Experiment Station, 1894.
 Treatment of Pear Orchard. Bulletin 31, Rhode Island Experiment Station, 1895.
- SCRIBNER, F. L.—Leaf-Blight and Cracking of the Pear. Report United States Department Agriculture, 1888, pp. 357-364.
 Fungous Diseases of the Grape and Other Plants, pp. 101-104.
- SORAUER, P.—Pflanzenkrankheiten, zweite auflage, II., pp. 372-377.
- TUBEUF. Diseases of Plants introduced by Cryptogamic Parasites, English Edition.
- WAITE, M. B.—Treatment of Pear Leaf-Blight in the Orchard. Journal Mycology, VII., No. 4, pp. 333-338.

* See, also, bibliography of pear scab.

III. PEAR SCAB.*

I. GENERAL ACCOUNT.

During the past two years a number of inquiries have been received concerning pear scab, and among the smaller orchardists or others with a small number of trees, equally as many inquiries

have related to the well-known pear blight. Consequently, it has seemed well to incorporate in this bulletin such brief accounts of these two diseases as will give the information desired.

The injurious effects of pear scab are well understood by many orchardists; and by some the disease is combated faithfully and successfully, but to others it is an inevitable attendant of pear culture. During the past summer I was surprised to find how often pear scab is confused with certain insect punctures and other minor injuries.



168.—*Summer Doyenne* badly injured by pear-scab.

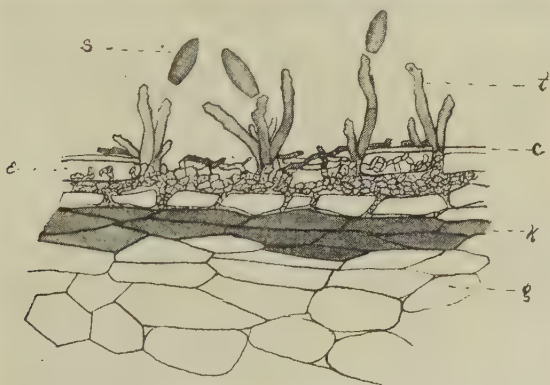
I presume, however, that no one who ever grew so susceptible a variety of pear as the Flemish Beauty could long remain ignorant of the scab. The pear shown in figure 168, is from a photograph of a Flemish

**Fusicladium pirinum* (Lib.) Fckl.

Beauty. Although much is lost when colors are not reproduced, one sees there the essential characteristics of the scab in pronounced form upon the fruit.

With many varieties of pear, this cracking may accompany the scab as well as the leaf blight, or, apparently even certain irritating external agencies may produce the cracking, provided the respective agencies affect the pear during the growing period.

On the fruit the pear scab produces at first merely brownish or olivaceous markings. These discolorations are due, in part, to a short surface growth of the fungus, and to the deadening of the epidermis of the pear. Summer Doyenne, illustrated in the



169.—A cross section through a scab spot on pear fruit, giving the location and the appearance of the fungus.

frontispiece, shows the characteristic appearance before there is any indication of cracking.

The figures do not show clearly any of these spots upon the leaves, but the leaves are often severely affected, the spots being usually more abundant in the neighborhood of the midrib on the under surface. During the past year Professor L. H. Bailey received from Michigan some leaves so badly affected that the fungous growth covered the greater portion of both surfaces, and the leaf was considerably curled therefrom.

Pear scab has been known botanically since 1832, when it was

found in Belgium; but it is only within the past twenty years that it has had a place in economic literature. Hereafter, at least until unsusceptible and otherwise satisfactory varieties are introduced, to the successful orchardist a knowledge of scab is as essential as a knowledge of pruning.

2. SPECIAL CHARACTERS OF THE FUNGUS.

(a.) *Microscopic appearance.*—The olivaceous growth on the fruit, leaves, and twigs is largely made up of short erect threads somewhat uneven at their tips. These threads produce the spores or reproductive bodies. A thin section through a scab



170.—*Germinating spores of the pear-scab fungus.*

spot on the fruit examined under the microscope shows what I have represented in figure 169. Over the entire surface of the pear, as of plants in general, there is a definite outer layer of cells which we call the epidermis, as shown at *e*. The outer wall of this epidermal layer usually becomes thickened into a very tough resistant cuticle, *c*, figure 169. Inside of the epidermal layer of the pear we find the pulpy cells and the gritty cells of the fruit without special regularity, as at *g*. In the diagram it will be seen that the mat-like mass of fungous threads is developed largely just beneath the epidermis,* and they never

It will be seen that the above description of the location of the hyphæ is somewhat different from that given by several authors. Sorauer states that the stroma occupies mainly the epidermal cells in apple scab. Aderhold† in his interesting paper on the *Fusicladia* finds the hyphæ always subcuticular at first, and mainly subcuticular throughout. My sections, made from pear fruit only, show that the principal stroma in this case is undoubtedly at first subepidermal. The sections studied were made from material imbedded in paraffine, and they were stained with the Ehrlich-Biondi-Heidenhain mixture.

* *Pflanzenkrankheiten*, Zweite auflage, II, 394.

† Aderhold, Cf. Bibliography.

extend very far into the pulp of the pear. They often penetrate the cells of the epidermis, deriving their nutriment entirely from these outer layers. The erect threads *t*, figure 169, arise from this mass of threads, break the cuticle, and produce the spores as seen at *s*. Later, the epidermis is ruptured, and then we find that a definite corky layer has been formed by the cells of the fruit below the diseased area, figure 169, *k*.

Figure 170 shows how these spores germinate. After falling upon the leaf or the fruit, with suitable conditions, the spore absorbs water, and pushes out a little thread, or germ tube. This germ tube has the power of passing in through the cuticle and epidermis, where it branches greatly and develops the thread-like mass of fungous hyphæ, and soon again the scab spot is seen on the surface.

(*b.*) *How the fungus passes the winter.*—It has been seen that pear scab often attacks the twigs of the first year. The fungous threads are extremely resistant, and buried in the bark of the twigs it is generally admitted that the disease may thus pass the winter, producing the following spring a crop of spores to reinfect the young branches and leaves, as well as the fruit clusters. It is also believed that the fungus may pass the winter in the diseased fruit and leaves. In Germany a winter stage of the fungus has been found belonging to the genus *Venturia*.

In artificial cultures on bean stems and other nutrient media, I have grown for some time the fungi of apple and pear scab. These cultures have yet given no indication of this other fruiting stage, or winter form of the fungus.

(*c.*) *Does Pear Scab differ from Apple Scab?*—It is well known that pear scab differs from apple scab in some particulars; but some have claimed that these differences are so small as not to denote that the fungi are distinct. However, it is of considerable practical importance to know that some recent work tends to show that these fungi are distinct species; hence, if this is true, pear scab cannot spread to the apple, and there cause apple scab, or vice versa.

3. VARIETIES AFFECTED.

Scab affects to a greater or less extent a number of the varieties commonly grown in New York. The data upon this subject

are limited, but it is generally reported that Le Conte, Kieffer, and Bartlett are less attacked than such varieties as Anjou, Lawrence, Duchess, Clairgeau, Sheldon, Seckel, Summer Doyenne, Flemish Beauty, and Jones. On Seckel, Flemish Beauty, and Summer Doyenne I have found it very abundant during the past two years. In a list of about twenty-four varieties given by Beach in bulletin 84 of the N. Y. State Exp. Sta. we find none other than the three mentioned included among those only slightly attacked.

4. REMEDIES.

Since we may assume that this fungus lives over winter in the young branches or diseased fruit, it is quite evident that there is all the more reason for beginning any work of prevention at the earliest time expedient. Fairchild found that before the flower buds open the young scab spots may appear upon them. It is very important to prevent the early establishment of the disease; for once having secured a foothold, spores are rapidly produced and dissemination is very rapid during seasons favorable for the disease.

For the prevention of this fungus, many experiments have been made at various stations with the different fungicides. During the past few years special attention has been given to pear scab at the Geneva Station in New York. The final results are not at all discordant with those of other stations, and recommendations are made somewhat accordingly. Spray three times with Bordeaux mixture of the 50-gallon strength.* The first spraying should be made before blossoming, but after the fruit buds burst; the second, immediately after the petals fall; and the third, about two weeks after the second.

REFERENCES TO LITERATURE.

- ADERHOLD, RUDOLPH.—Die Fusicladien unserer Obstbäume, I Teil. Landwirtschaftliche Jahrbücher 25; 875-914; 1895; pl. XXIX-XXXI.
ARTHUR, J. C.—Leaf Blight and Pear Scab. Report N. Y. State Experiment Station, Geneva, 1884, 367-368.
BAILEY, L. H.—*Fusicladium pirinum*. Bulletin XIX, Cornell University Experiment Station, Ithaca, N. Y., 1890, pp. 49 and 52.

* See page 604. Beach recommends the 66-gallon formula.

- BEACH, S. A.—[Report of the committee on plant diseases.] Report of Proceedings Western N. Y. Hort. Soc. 1893, pp. 14-20.
Experiments in Preventing Pear Scab. Report N. Y. State Experiment Station, Geneva, 1893, pp. 694-717.
Experiments in Preventing Pear Scab in 1893. Bulletin 67 N. Y. State Experiment Station.
Some experiments in 1893 in Treating Pear to Prevent Pear Scab. Report of Proceedings Western N. Y. Hort. Soc., Rochester, 1894, pp. 56-60.
Treatment of Pear Scab in 1894. Bulletin 84 N. Y. State Experiment Station, Geneva, Jan. 1895, also Report 1894, pp. 647-663.
- CHESTER, F. D.—Spraying with Potassium Sulphide for Pear Scab. Bulletin VIII, Del. Experiment Station, 1890, pp. 11-14.
- CHURCHILL, G. W.—Bulletin 35 N. Y. State Experiment Station, Geneva, N. Y., 1890; also Report 1890, pp. 337-339.
- ERIKSSON, J.—Bidrag till Kannedomen om vara odlade växters sjukdomar [Reviewed in Bot. Centr. XXVI, 347-348, 1886.]
- GALLOWAY, B. T.—Experiments in the Treatment of Pear Leaf-Blight, Cracking and Scab. Bull. 3, Div. Veg. Path., U. S. Dept. Agr. 2892.
- GALLOWAY, B. T.—Pear Scab and Leaf-Blight. Journal Mycology VI, 14.
and FAIRCHILD, D. G.—Treatment of Pear Leaf-Blight and Scab in the Orchard. Jour. Myc. VI, pp. 137-142.
- GREEN, W. T.—Pear Scab. Bulletin VI, Ohio Experiment Station, 1891, pp. 212-213.
- GOFF, E. S.—Soda Hyposulphite contrasted with Potassium sulphide and Calcium Sulphide for the Apple Scab. Report N. Y. State Experiment Station, 1888, pp. 154-157.
- JONES, L. R.—Apple and Pear Scab. Pt. IV, Bulletin 28, Vermont Experiment Station, pp. 30-34.
Report Vermont Experiment Station, 1891, p. 132.
Bulletin 44, Vermont Experiment Station.
Report Vermont Experiment Station, 1894, pp. 109-113.
- KINNEY, F. L.—The Scab of the Apple and Pear. Report Rhode Island Experiment Station, 1894, pp. 185-187.
- LAMSON, H. H.—Spraying Experiments in 1894. Bulletin 27. New Hampshire Experiment Station.
- LUDWIG.—Die Niederen Kryptogamen, p. 316.
- SCRIBNER, F. L.—Fungous Diseases of the Grape and Other Plants, 1890, Chapter XIV.
- SORAUER, P.—Pflanzenkrankheiten, Zweite auflage II, pp. 8 and 395-397.
- STURGIS, W. C.—"Scab" of Apple and Pear. Bulletin 111, Conn. Experiment Station, New Haven, 1892.
- STURGIS, W. C.—Diseases of the Pear. Scab. Bulletin 115, Conn. Experiment Station p. 5, 1893.

STURGIS, W. C.—Spraying for “Scab” of Apple and Pear. Report Conn. Experiment Station, 1893, pp. 72-73.

TUBEUF, K. F. von.—Diseases of Plants induced by Cryptogamic Parasites, English Edition pp. 218-220, also 507.

PEAR BLIGHT*. (*Fire Blight*.)

I. GENERAL APPEARANCE.

Of all the diseases which affect the pear, there is no other which commands attention like the pear blight, or so called fire blight. One may say that it commands attention, for surely its injuries are usually sufficiently evident,—the progressive blackening of leaf and twig, or the death of the tree limb by limb,—injuries which must appeal to any one with due interest, either aesthetic or pecuniary. The most evident cases of blight are at first manifest on the tender shoots or younger twigs by the blackened leaves and withered stems ; gradually the progress of the disease is downward, an inch more or less each day, it may be ; and finally the death of largest limbs may point out the very destructive course of this malady.

With the more susceptible varieties, and under conditions favoring more succulent growth, blight may involve the entire body of the tree. Often, however, the disease is temporarily or permanently checked at definite places by the denser wood or other conditions, and at such places there is a sharp line of demarcation between the healthy part below, and the shriveled, blackened part above. In larger limbs, this break is quite as evident by the cracked appearance of the bark.

Unfortunately, the forms of injury above described are not the only ones. Those who have suffered by this disease know well that frequently the blossoms and the young fruit turn black and dry up. The disease may then remain in the fruits alone, or it may here, also, extend itself to larger limbs through the fruit spurs and twigs.

2. HISTORICAL.

Pear blight has probably been known in this country for over a century. It was crudely attributed to one or another of countless causes until 1880. At that time, through the studies of

* *Bacillus amylovorus*, Burrill.

Professor T. J. Burrill, of the University of Illinois, we became acquainted with the indisputable means by which this disease is induced and disseminated. The germs of pear blight belong to that class of minute organisms known as bacteria, so many species of which are concerned in the many contagious diseases of man and animals, and so many others useful in various processes of fermentation. From 1883 to 1887, while connected with the Geneva station, Arthur greatly increased our knowledge of this disease. Lastly, Waite, of the U. S. Department of Agriculture, has cleared up many points regarding the disease in the flower, its spread by bees and other insects, with added suggestions concerning its eradication.

3. SPECIAL FEATURES OF THE DISEASE.

(a.) *The Bacteria*.—We may well dwell upon some of the interesting points concerning the life and action of these pear blight bacteria. Often when young shoots are affected, slight ruptures in the bark may be noted, and from these ruptures may be exuded minute gummy droplets. Examining under high powers of the microscope such exudation, or even the sap from diseased parts, we find innumerable little oval bodies floating about singly or in chains of two or more, each individual being a plant with great power of rapidly growing longer and dividing again and again into similar simple bodies, see figure 171. These individual bacteria are so small that it requires a mass of them to be evident to the unaided eye; indeed, to attempt to see the individuals in the little gummy droplet, or in the sap, would be like an attempt to see the separate rain drops in the approaching storm more than a mile away.



171.—*The bacteria of pear-blight.*

Nevertheless, we can grow these bacteria in large quantity upon slices of cooked potato, beef broth, and many other culture media. Here, with certain precautions, they may be grown entirely

free from other germs,—in pure cultures. Then these cultures may be used to inoculate healthy twigs, and the production of the disease in the latter gives all needed evidence of the true cause. These inoculation experiments were made by Burrill, and they have been confirmed time and again; so that, (1) finding these disease germs in affected twigs, (2) securing pure cultures of them, (3) by inoculation producing the disease, (4) characterized by the same germ,—these make the cause undoubtable. Thus we learn, also, that the disease is contagious, and that we need to take precautions against its spread.

(b.) *Kinds of trees affected.*—By means of cross inoculations from tree to tree it has been abundantly shown that the fire blight, or twig blight, of the apple, quince, and crab; of the mountain ash, service berry, and several species of hawthorn are all due to the same organism; and hence the disease may spread from one to the other. During the past two years, I have found it attacking a Japanese Hawthorn and *Pirus Kaido*. In short, this blight is a disease of many pomaceous plants of the rose family.

(c.) *Bacteria in the flowers.*—Waite has shown that these bacteria will grow freely in the nectaries of the pear flowers, later penetrating into the solid tissues of flower, fruit, and stem. By the agency of bees, which feed upon this nectary, the disease may be abundantly disseminated during the blossoming period; but the bees are essential for cross pollination of the flowers.*

(d.) *Bacteria in the wood.*—The germs cannot enter the older tissues except through abrasions of the bark, and it is believed that there must be some insect or other slight injury in order that they may enter even the growing tip. The leaves afford no inlet for them, and localized trunk injuries may have been established by means of young shoots or water suckers.

In order to understand how these bacteria may pass downward, once having gained entrance, we must recall the structure of a limb. Just between the soft bark and the wood is a layer of growing tissue, the cambium, which develops each year a layer of new wood on the inside, and a layer of new bark on the out-

*Waite, M. B.—The Pollination of Pear Flowers, Bulletin 5., Div. vegetable Pathology, U. S. Dept. Agr.

side, so that all of the young active tissue is very closely connected. The younger inner bark however is the favorite region for the bacterial growth containing as it does much nutritive material.

Sometimes the cambium is also affected. In these tissues the bacteria grow abundantly, passing gradually from cell to cell and destroying much of the living portion of the branch as they go ; but never circulating rapidly from branch to branch. The surface is reached by means of the little cracks through which the gummy exudations arise.

4. REMEDIES.

(a.) *The knife and the saw.*—With a disease working as this does, it is very evident that there is no chance either for cure or prevention by means of spraying. The heroic treatment of the knife and saw must be adopted and vigorously pursued, as has been claimed from the beginning. The blackened leaves, alone, must not serve as signs of the diseased area, but one must examine carefully the branches and remove them six inches or more below the lowest discolorations. Often before cutting, pruners slice the bark downward to see where the injury ends. This should not be done ; it is better to be sure that you are below the infected area, and run no such risk of infecting anew the tissues below. The cut surfaces of larger limbs and branches should be painted for protection against wound rots.

(b.) *When to cut.*—Cutting out diseased portions should be done whenever the disease is evident. This may check the injuries temporarily ; but it has been shown that much can be done in the autumn to prevent the establishment of the disease the following spring. It has long been known that the disease may pass the winter in the branches by a slow growth in the neighborhood of late infections. Thorough work of eradication should especially be performed after the season of growth. Then cut out every diseased branch and burn, so that in the spring when the succulent growth begins again, there will be few places in which insects may come in contact with the bacterial exudations. Sometimes trees which are affected during the summer and autumn show no indication of the disease the next year, and

I have observed this especially in the case of hawthorn and apple; but it seems much more likely to pass the winter in the pear.

(c.) *Conditions favoring the disease.*—The knife is our only hope of extermination; but there are undoubtedly conditions which favor the disease. In a succulent, rapidly growing tree the bacteria find more favorable conditions for their development than in one which grows slowly, yet with sufficient vigor. For this reason, too much nitrogenous manure is dangerous; and, for the same reason, a succulent growth induced by severe pruning should be avoided. It has been demonstrated by experiment that withholding water from potted trees which had been inoculated with blight would immediately stop the course of the disease.

REFERENCES TO LITERATURE.*

- ARTHUR, J. C.—Pear Blight. Report N. Y. State Experiment Station, 1884, pp. 357-367.
 Pear Blight, Bulletin II. New Ser., N. Y. State Experiment Station.
 Proof that Bacteria are the direct cause of the disease in trees known as pear blight, Proc. Amer. Assoc. Adv. Sci., XXXIV, 295-298, 1885.
 [Same in Bot. Gaz. X, p. 343-345, 1885.]
 Pear Blight. Report N. Y. State Experiment Station, Geneva, 1885, pp. 241-248.
 Pear Blight and its cause, Amer. Nat. XIX, pp. 1177-1185, 1885.
 History and Biology of Pear Blight. Proc. Phila. Acad. Nat. Sci., 1886, pp. 322-342.
 Pear Blight. Report N. Y. State Experiment Station, 1886, pp. 275-289; also "Important articles on Pear Blight," same report, pp. 300-315.
 BECKWITH, M. H.—Blight affecting the body of pear and apple trees. Report Delaware Experiment Station, 1895, pp. 158-159.
 BURRILL, T. J.—Anthrax. of fruit trees or the so-called fire blight of pear and twig blight of apples. Proc. Amer. Assoc. Adv. Sci., XXIX, pp. 583-597.
 Blight of Pear and Apple Trees. Report Industrial University of Illinois, 1880, pp. 62-84.
 Pear Blight, Amer. Naturalist, XV, pp. 529-532, 1881.
 Trans. Ill. Hort. Soc., 1880, pp. 157-168.
 Bulletin 2, Illinois Experiment Station, pp. 16 and 17.
 CLARK, J. W.—Pear or Fire Blight. Bulletin 16, Missouri Experiment Sta.

* For earlier references see Arthur, J. C., Important articles on Pear Blight. Report N. Y. State Experiment Station, 1886, pp. 300, 315.

- STURGIS, W. C.—Fire Blight. Report Conn. Experiment Station, 1894, pp. 113-117.
- TUBEUF, K. F. VON.—Pear and Apple Blight. Diseases of Plants induced by Cryptogamic Parasites, English edition, pp. 531-532.
- WAITE, M. B.—Pear Blight. Report of Proc. Western N. Y. Hort. Soc., 1895, pp. 96-99.
- The cause and prevention of Pear Blight. Year Book of the Department of Agriculture, 1895, pp. 295-300.

THE FOLLOWING BULLETINS ARE AVAILABLE FOR DISTRIBUTION TO
THOSE WHO MAY DESIRE THEM.

- | | | | |
|-----|--|-----|--|
| 39 | Creaming and Aerating Milk, 20 pp. | 104 | Climbing Cutworms in Western N. Y., 51 pp. |
| 40 | Removing Tassels from Corn, 9 pp. | 105 | Test of Cream Separators, 18 pp. |
| 41 | Steam and Hot-Water for Heating Greenhouses, 26 pages. | 106 | Revised Opinion of the Japanese Plums, 30 pp. |
| 49 | Sundry Investigations of 1892, 56 pp. | 107 | Wireworms and the Bud Moth, 34 pp. |
| 53 | Edema of the Tomato, 34 pp. | 109 | Geological History of the Chautauqua Grape Belt, 36 pp. |
| 55 | Greenhouse Notes, 31 pp. | 110 | Extension Work in Horticulture, 42 pp. |
| 58 | Four-Lined Leaf-Bug, 35 pp. | 116 | Dwarf Apples, 31 pp. |
| 61 | Sundry Investigations of the Year 1893, 54 pp. | 117 | Fruit Brevities, 50 pp. |
| 64 | On Certain Grass-Eating Insects, 58 pp. | 119 | Texture of the Soil, 8 pp. |
| 69 | Hints on the Planting of Orchards, 16 pp. | 120 | Moisture of the Soil and Its Conservation, 24 pp. |
| 71 | Apricot Growing in Western New York, 26 pp. | 121 | Suggestions for Planting Shrubbery, 30 pp. |
| 72 | The Cultivation of Orchards, 22 pp. | 122 | Second Report upon Extension Work in Horticulture, 36 pp. |
| 73 | Leaf Curl and Plum Pockets, 40 pp. | 123 | Green Fruit Worms, 17 pp. |
| 74 | Impressions of the Peach Industry in N. Y., 28 pp. | 124 | The Pistol-Case-Bearer in Western New York, 18 pp. |
| 75 | Peach Yellows, 20 pp. | 125 | A Disease of Currant Canes, 20 pp. |
| 76 | Some Grape Troubles in Western N. Y., 116 pp. | 126 | The Currant-Stem Girdler and the Raspberry-Cane Maggot, 22 pp. |
| 77 | The Grafting of Grapes, 22 pp. | 127 | A Second Account of Sweet Peas, 35 pp. |
| 78 | The Cabbage Root Maggot, 90 pp. | 128 | A Talk about Dahlias, 40 pp. |
| 79 | Varieties of Strawberry Leaf Blight, 26 pp. | 129 | How to Conduct Field Experiments with Fertilizers, 11 pp. |
| 80 | The Quince in Western N. Y., 27 pp. | 130 | Potato Culture, 15 pp. |
| 81 | Black Knot of Plums and Cherries, 24 pp. | 131 | Notes upon Plums for Western New York, 31 pp. |
| 82 | Experiments with Tuberculin, 20 pp. | 132 | Notes upon Celery, 34 pp. |
| 84 | The Recent Apple Failures in N. Y., 24 pp. | 133 | The Army-Worm in New York, 28 pp. |
| 87 | Dwarf Lima Beans, 24 pp. | 134 | Strawberries under Glass, 10 pp. |
| 92 | Feeding Fat to Cows, 15 pp. | 135 | Forage Crops, 28 pp. |
| 93 | Cigar-Case-Bearer, 20 pp. | 136 | Chrysanthemums, 24 pp. |
| 95 | Winter Muskmelons, 20 pp. | 137 | Agricultural Extension Work, sketch of its Origin and Progress, 11 pp. |
| 96 | Forcing House Miscellanies, 43 pp. | 138 | Studies and Illustrations of Mushrooms; I, 32 pp. |
| 97 | Entomogenous Fungi, 42 pp. | 139 | Third Report upon Japanese Plums, 15 pp. |
| 98 | Cherries, 34 pp. | 140 | Second Report on Potato Culture, 24 pp. |
| 100 | Evaporated Raspberries in New York, 40 pp. | 141 | Powdered Soap as a cause of Death Among Swill-Fed Pigs, 12 pp. |
| 101 | The Spraying of Trees and the Canker Worm, 24 pp. | 142 | The Codling-Moth, 69 pp. |
| 102 | General Observations in Care of Fruit Trees, 26 pp. | 143 | Sugar Beet Investigations, 88 pp. |
| 103 | Soil Depletion in Respect to the Care of Fruit Trees, 21 pp. | | |